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Analysis of the COVID-19 Pandemic on FAAMG Companies' Performances Under the Fama-French Five-Factor Model

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Abstract: The COVID-19 pandemic has led the U.S. stock market to tumble during the last two years. To further discover the effect of the pandemic on specific companies, this paper utilizes the Fama-French five-factor model to analyze the performance changes for FAMMG companies before and after the COVID-19 outbreak. OLS method is applied to the FAAMG companies' stock returns to examine the fitness of the model, and the fitness is strengthened after the outbreak. The pandemic causes significant changes in betas of the Fama-French five-factor model, specifically Robust minus Week (RMW) and Conservative minus Aggressive (CMA).

Keywords: Fama-French, Technology Industry, Industrial Analysis, Asset Pricing, COVID-19.

1. Introduction

The capital asset pricing model (CAPM), the predecessor of the Fama-French three-factor and five-factor model, was mainly introduced by Treynor, Sharpe, and Linter to help anticipate the behavior of capital markets by incorporating conditional risks [1-3]. It aimed to evaluate the correlation between an asset's beta and its corresponding expected return [4]. However, through the development of the business and market, companies are facing a myriad of factors. Thus, A model with more subfactors is needed to increase its predictive and descriptive power. In 1993, Fama and French delivered another two factors Small minus Big (SMB) and High minus Low (HML) to the CAPM model to better illustrate the market risks. SMB aimed to explain the size effect and HML to explain the value effect. The improvised model rendered finer understanding of an average rate of returns on the U.S. common stocks [5-6]. In 2014, the Fama-French five-factor model was presented, which added two more elements to the three-factor model, namely RMW and CMA. RMW was created to illustrate the profitability of return on diversified portfolios of stocks and CMA was to explain the aggressiveness of investment styles, and the model was tested comprehensively by Fama and French on the international market [7-8].

FAAMG is the acronym for the Big Five companies Meta, Apple, Amazon, Microsoft, and Google, and the paper still uses the acronym FAAMG though Facebook changed its company name to Meta [9].

Due to the upsurge of the COVID-19 infectivity, the worldwide economy plummeted, especially in countries like the U.S. Thus, the paper's objectives are to examine the impact of COVID-19 on FAAMG companies under the utilization of the Fama-French empirical model and to employ a

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comparatively comprehensive model to rigorously inspect their stock movements in the U.S. market throughout the pandemic. This paper is capable of providing insights into the technology companies' performances during the pandemic and discover specific patterns of the companies' stock prices when they encounter future infectious diseases.

2. Models and Methodologies

2.1. CAPM and Fama-French Models

The CAPM model, advanced during the 1960s by prestigious economists Treynor, Sharpe, and Linter, produced the first coherent framework for connecting expected return on investment to the risk of the investment. The model considers risk-free risk, beta, and market risk premium factors, as:

$$R_i = \alpha + R_f + \beta_i(R_m - R_f) \quad (1)$$

In the formula, R_i refers to the expected return, R_f to the risk-free rate, β_i to the beta, and R_m to the market risk of the investment. The expression of $R_m - R_f$ represents the market risk premium in the formula. α denotes the historic excess return of the investment over the specific benchmark index.

To better help explain the variability of the market, Fama and French introduced two more factors to the CAPM model in 1992, as:

$$R_{it} = \alpha_{it} + R_{ft} + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \epsilon_{it} \quad (2)$$

Where SMB represents the past excess returns of small-cap firms over large-cap firms, and HML is the historic excess returns of high book-to-price ratio stocks over low book-to-price ratio stocks. s_i and h_i are the coefficients of SMB and HML respectively. ϵ_{it} refers to the residuals.

In 2014, Fama and French adapted the Fama-French three-factor model to include two more elements to illustrate the profitability facet of companies in the stock market and the new equation becomes:

$$R_{it} = \alpha_{it} + R_{ft} + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \epsilon_{it} \quad (3)$$

The first variable RMW explains the return spread of the most lucrative minus the least profitable companies; the second variable CMA represents the return spread of conservatively invested minus aggressively invested companies. r_i and c_i are the coefficients of RMW and CMA respectively.

The paper utilizes the Ordinary Least Squares (OLS) method to estimate the coefficients of the Fama-French five-factor model during the COVID-19 to illustrate how the Big Five reacted to this global epidemic.

2.2. Data Collection Process

The paper obtains the Fama-French five factors (2x3) data from Dartmouth College's Tuck School of Business data library (the 2022 CSRP database) on daily basis. The stocks' returns of the Big Five companies are retrieved from Yahoo! Finance. Moreover, according to the COVID-19 clinical update article, the pandemic outbreak is around March 2020 in the U.S. [10]. Thus, the paper chooses the data from March 2020 to February 2021 (including 251 trading days) as the data after the pandemic outbreak; accordingly, to examine the companies' changes during the pandemic, the paper also chooses the data from March 2019 to February 2020 (including 252 trading days) as a

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comparison. The historical data can fit in the OLS regression model and can be analyzed to examine the changes in the market.

3. Model Efficiency

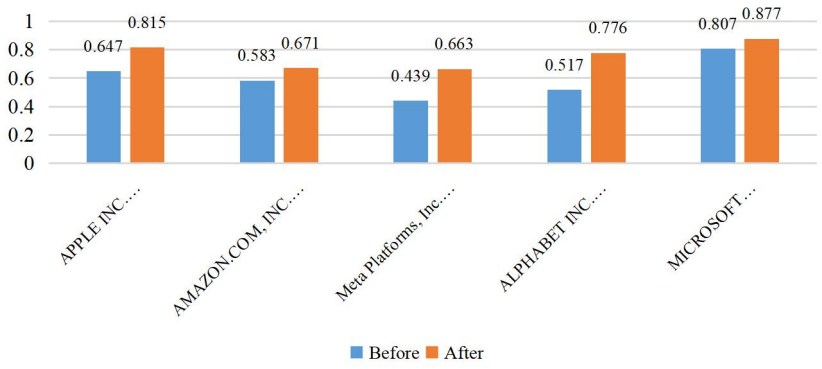

Figure1： R-squared values of the Big Five before and after COVID-19 outbreak.

The paper performs OLS regression by utilizing the Big Five's corresponding stock and Fama-French five-factors data in two 1-year periods (before and after the COVID-19 pandemic outbreak) to indicate the efficiency of the Fama-French empirical model. The paper utilizes the ordinary R-squared values returned by the regression as the results.

Using the significance level of 0.05, the average R-squared value before COVID-19 is 0.599, and 0.760 after. All the Big Five's R-squared values increase after the COVID-19 outbreak, which means Fama-French five-factor model has a better fit.

The paper also examines the returned statistics of the Durbin-Watson test[11], skewness, and kurtosis. In this paper, the Durbin-Watson test is used to examine if the residuals from the Fama-French empirical model have any autocorrelation, and skewness and kurtosis are employed to examine the normality of the stock returns.

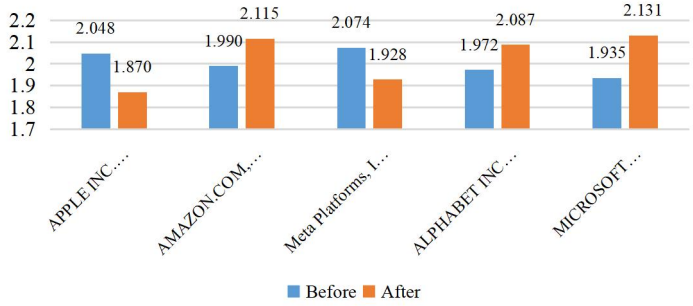

Figure2： Durbin-Watson statistic of the Big Five before and after COVID-19 outbreak.

The Durbin-Watson statistic, theoretically, has a potential value range of 0 to 4. The value from 0 to less than 2 represents there is positive autocorrelation, the value of 2.000 means there is no autocorrelation, and the value from 2 to 4 indicates there is negative autocorrelation. In this regression analysis, only Apple has a negative autocorrelation before the COVID-19, meaning the historical stock returns and future stock returns are negatively correlated. After the COVID-19 outbreak in the U.S., two of the Big Five companies Apple and Meta indicate positive autocorrelations, in which their historical stock returns and future stock returns are positively correlated.

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Table1: Normality statistics of the Big Five before and after COVID-19 outbreak.

	APPLE		AMAZON		META		ALPHABET		MICROSOFT	
	B/A		B/A		B/A		B/A		B/A	
Kurtosis	7.474	7.264	23.010	5.325	7.560	5.159	24.966	12.186	6.524	6.845
Skewness	0.863	0.760	2.615	0.317	-0.159	0.472	0.807	1.616	0.858	1.043

The Table 1 uses B/A as the acronym for before and after to indicate the returned results. The kurtosis and skewness statistics returned by the regression analysis indicate that the Big Five's stock returns are not normally distributed because a normal distribution has a kurtosis of 3 and a skewness of 0. The distributions of these five stocks are fat-tailed, exhibiting large leptokurtosis, especially for Amazon and Alphabet before the pandemic spread in the U.S., and the probabilities of more extreme returns can happen. However, there is one abnormality in Meta's skewness statistic before the epidemic happens. The result of negative skewness reveals that frequent small gains and few significant losses can occur regarding Meta's stock.

After the COVID-19 spread in the U.S., the kurtosis of Big Five's stock returns decreased (except for Microsoft) and centered toward the mean. The skewness decreased for Apple and Amazon and increased for Meta, Alphabet, and Microsoft. The pandemic negatively impacted the Big Five's stock performances, which decreases the probability of extreme profits and losses.

4. Coefficients Estimation

4.1. Coefficients Estimation Results

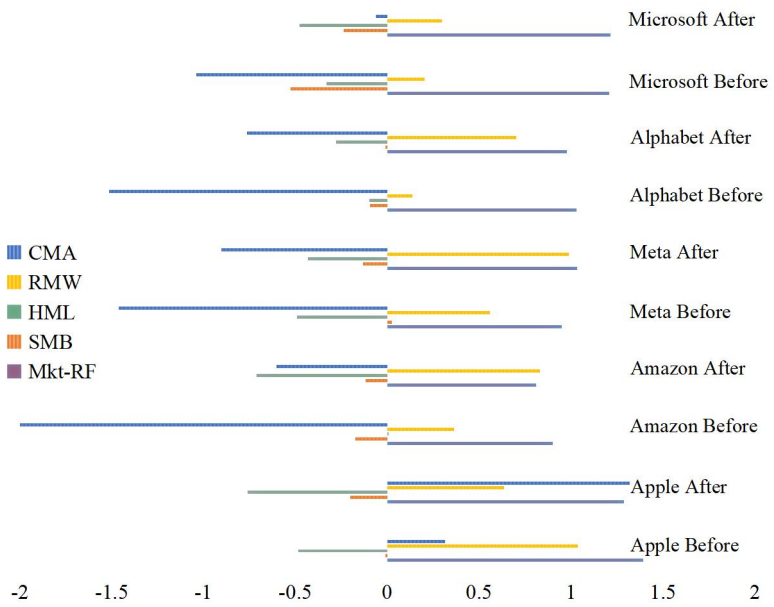

Figure3： Coefficients estimation results before and after COVID-19 outbreak.

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4.2. Coefficients Estimation Discussion

Table2: P- values of coefficients estimation before and after COVID-19 outbreak.

	APPLE		AMAZON		META		ALPHABET		MICROSOFT	
	B/A		B/A		B/A		B/A		B/A	
Mkt-RF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SMB	0.926	0.028	0.166	0.243	0.892	0.276	0.516	0.895	0.000	0.001
HML	0.000	0.000	0.985	0.000	0.006	0.000	0.520	0.000	0.000	0.000
RMW	0.000	0.000	0.079	0.000	0.048	0.000	0.571	0.000	0.133	0.014
CMA	0.251	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.629
Intercept	0.031	0.379	0.734	0.337	0.902	0.992	0.956	0.613	0.159	0.985

The market risk premium is calculated by using market return minus risk-free return, and the data retrieved from Kenneth R. French data library uses 1 month T-bill return as the risk-free return. The beta of market risk premium is a measure of volatility used in the Fama-French empirical model, and the calculated results indicate the Mkt – RF factor is significant. COVID-19 has caused tremendous shock on the market, but for FAAMG companies, the impact is not that critical. For Amazon, its beta of market risk premium is less than 1 before and after the pandemic, which means its stock returns are less dependent on the market return. For Apple and Alphabet, their betas decrease after the pandemic outbreak and their stock returns become less volatile. Moreover, only the beta of Meta increases. The results may seem to be counterintuitive that the overall stock returns of FAAMG companies become more stable compared to the market after the COVID-19 spread in the U.S.

The results show that for Amazon, Meta, and Alphabet, the SMB factor is not statistically significant because their P-values are all greater than 0.05. For Apple, there is a significant change in the beta of the SMB factor. The beta is negative after the pandemic outbreak which means Apple is a large-cap company. Moreover, the beta becomes far lower than before which means Apple's excessive stock return can be explained proportionally more by the SMB factor. For Microsoft, it is also a large-cap company, and its excessive return can be explained proportionally less by the SMB factor.

As Figure 3 shows above, all the betas of the HML factor for FAAMG companies are negative except for Amazon's beta before the pandemic. This demonstrates Amazon behaves like a value stock before COVID-19 but changes its behavior and behaves like a growth stock after. It fits the circumstance in which pandemic drives shopping online, thus accelerating Amazon's massive growth. However, for Amazon and Alphabet, their betas of HML factor were insignificant before the pandemic. Thus, all FAAMG companies have low book-to-market value ratios after the pandemic, and their investment risks are lower than other value stocks on the market.

Betas of RMW, which stands for the profit effect, are insignificant for Amazon, Alphabet, and Microsoft before the pandemic. However, the profit effect, in which companies with higher profitability would generate higher future returns, applies to all FAAMG companies after the pandemic outbreak. The profit effect for Apple is weakened and strengthened for Meta.

The factor of CMA represents the investment effect. Though the values of beta for Apple are not significant before COVID-19, there exists an anomaly for Apple: it has the largest and the only positive coefficient of CMA factor among FAAMG companies. The trend of betas' change for the

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rest of the companies is consistent: they all have large negative values before the pandemic and then increase after.

In the regression, the last variable is the intercept. It indicates alpha, the excess return of the investment compared to the benchmark. However, it is not relevant in the regression since approximately all the intercepts are insignificant.

5. Conclusion

The paper is designed to examine the impact of COVID-19 pandemic on FAAMG companies by utilizing the Fama-French five-factor model. The model fits more accurately following the outbreak of the pandemic, and the impact for the five companies is somewhat counterintuitive: most FAAMG companies gain massive profits and perform better on the stock market than before. Moreover, the five factors change dramatically after the pandemic outbreak. However, COVID-19 is still an ongoing global event, and the timeline this paper chooses is limited. Situations may change for companies as time elapses, and so does the nature of Fama-French factors. The future research of this paper can focus on evaluating self-build portfolios using the Fama-French empirical model over a longer time span.

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